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# Introduction to PowerFilm®

**PowerFilm®**
PowerFilm® is the world's leading thin film photovoltaics. PowerFilm products are paper thin, offer unsurpassed flexibility, are durable, and have a significant weight advantage over heavier metal-based and glass-based solar modules.

The PowerFilm product line offers a full line of products for diverse applications and use environments. The line ranges from small 3-volt modules for wireless electronics to modules 20 Watts and larger. There are PowerFilm solar modules specifically designed for wireless electronics, RC aircraft, and permanent outdoor applications.

PowerFilm can be easily integrated with devices. Its thin profile and flexibility make it a top choice of product designers and engineers.

**Technology**
Imagine taking paper-thin plastic film and making it generate power again and again. That's PowerFilm.

PowerFilm integrated solar modules have a paper thin durable polymer substrate 2 mils (0.05 mm) or less thick and are monolithically integrated. Environmentally-friendly amorphous silicon is the semiconductor absorber layer.

PowerFilm is developed and manufactured by Iowa Thin Film Technologies (ITFT). Founded in 1988, ITFT is the leader in monolithically-integrated semiconductor devices on plastic, using its proprietary roll-to-roll manufacturing technology platform.

**PowerFilm® Wireless Electronics Series**
Modules in the PowerFilm® Wireless Electronics Series offer a new opportunity to solve the old problem of limited power for wireless electronics for portable and remote applications. PowerFilm® Wireless Electronics modules are lightweight, paper thin, and durable. Their ultra-thin profile enables them to be easily integrated with devices for solar recharging or direct powering. Modules have been specifically developed to recharge AA, AAA, and 6- and 12-volt batteries. These modules do not have a UV-stabilized surface. For connection, just solder or crimp to the copper tape.

**PowerFilm® RC Aircraft Series**
The PowerFilm® RC Aircraft Series modules are designed to be easily integrated with RC Aircraft. These PowerFilm® modules are very lightweight, can be soldered to from the back of the module via the extended copper tape, and have an extra edge seal for protection from fuel contamination and weather. Modules are available with a strong pressure sensitive adhesive for simple bonding. These modules do not have a UV-stabilized surface. For connection, just solder to the copper tape.

**PowerFilm® WeatherPro™ Series**

The PowerFilm® WeatherPro™ Series is the right choice for permanent outdoor applications that are directly exposed to the elements. The especially rugged construction of these PowerFilm® modules includes a UV-stabilized surface, extra edge seal for weather protection, and tin-coated copper leads that extend from the module. Coating the leads with an RTV silicon compound can provide a tightly sealed package.

# PowerFilm® Product Line Overview

The PowerFilm® Product Line Overview highlights the solar modules available in each PowerFilm® Series. We strongly encourage first to try one of these standard products. If you require a custom product to meet your needs, please contact your PowerFilm® representative.

# Product Line Overview

March 20, 2003

| Operating Voltage | PowerFilm® Wireless Electronics Series | PowerFilm® RC Aircraft Series | PowerFilm® WeatherPro™ Series |
|---|---|---|---|
| **3 V** | PowerFilm SP3-37<br>PowerFilm TX3-25<br>PowerFilm MP3-37 | | |
| **3.6 V** | PowerFilm MPT3.6-75<br>PowerFilm MPT3.6-150 | | |
| **4.2 V** | PowerFilm SP4.2-37 | | |
| **4.8 V** | PowerFilm MPT4.8-75<br>PowerFilm MPT4.8-150 | | |
| **6 V** | PowerFilm MPT6-75<br>PowerFilm MPT6-150 | | |
| **7.2 V** | PowerFilm MP7.2-75<br><br>PowerFilm MP7.2-150 | PowerFilm RC7.2-37<br>PowerFilm RC7.2-37 PSA<br>PowerFilm RC7.2-75<br>PowerFilm RC7.2-75 PSA | PowerFilm P7.2-75<br><br>PowerFilm P7.2-150 |
| **15.4 V** | PowerFilm MPT15-75<br>PowerFilm MPT15-150 | | PowerFilm PT15-75<br>PowerFilm PT15-150<br>PowerFilm PT15-300 |

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# PowerFilm® Instructions

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# I PowerFilm® Module Polarity Information

**It is extremely important to recognize the correct polarity of the PowerFilm® modules!** The positive end of the solar module is shown in the diagram below. A diode, such as 1N5817, is recommended to prevent the solar module from draining the battery when the solar module is in the dark. A diode is not required for a battery-free electrical device. The positive end of the module connects to the positive end of the load. The negative end of the module is also shown in the diagram and should be connected to the negative end of the load. The recommended connector wire size is a minimum size of 24 gauge. As an extra measure, connect the solar module to a digital multimeter for polarity (+,-) identification. On solar modules with copper tape leads, remove a small piece of the clear coating that is on top of the copper tape to ensure good contact between the alligator clips of the digital multimeter and the copper tape.

**Warning! Do not connect a charged battery backwards or reverse polarity to the solar module, this will destroy the solar module and may cause the battery to explode causing bodily harm, even death!**



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# II PowerFilm® Module Selection

Select PowerFilm® modules according to 1) Operating Voltage and Operating Current Required, 2) Use Environment, and 3) any Specific Applications Needs.

## 1. Module Selection: Operating Voltage and Operating Current Required

Identify the Operating Voltage and Operating Current that your system requires. For direct powering devices, calculate the requirements of the total system.

For charging batteries, see the notes below:

DO NOT CHARGE ALKALINE BATTERIES. THEY ARE NOT RECHARGEABLE.

CONTACT YOUR BATTERY MANUFACTURER FOR CONFIRMATION THAT YOUR BATTERY IS APPROPRIATE FOR YOUR SYSTEM WITH THE SOLAR MODULE.

**Charging Batteries: Voltage**

First, select the required Operating Voltage of the solar module for your load. As a general rule of thumb, a solar module with an Operating Voltage of 3-3.6 volts will charge 2 AA rechargeable 1.2 volt batteries. A solar module with an Operating Voltage of 7.2 volts will charge 5 AA rechargeable 1.2 volt batteries or a 6 volt gel or lead acid battery. A solar module with an Operating Voltage of 15.4 volts will charge a 12 volt gel or lead acid battery.

**Charging Batteries: Current**

Second, select the appropriate Operating Current of the solar module to charge your load.
As a general rule, do not charge a rechargeable battery with more current that 10% of its rated capacity. For example, a 700mA-hour battery can be safely charged with a solar module that delivers an Operating Current up to 70mA.

**Connecting Modules for Higher Operating Voltage and Current**

You can parallel and series connect solar modules to achieve higher voltage (series connected) or higher current (parallel connected). However, only put like modules together: for example, two MP3-37s or two MP7.2-75s, but do not mix them. Parallel connecting two similar modules will double the output current and series connecting three identical modules will triple the output voltage.

**WARNING! WE DO NOT RECOMMEND SERIES CONNECTING SOLAR MODULES FOR AN OUTPUT VOLTAGE GREATER THAN 48V. VOLTAGES ABOVE THIS CAN BE DEADLY!**



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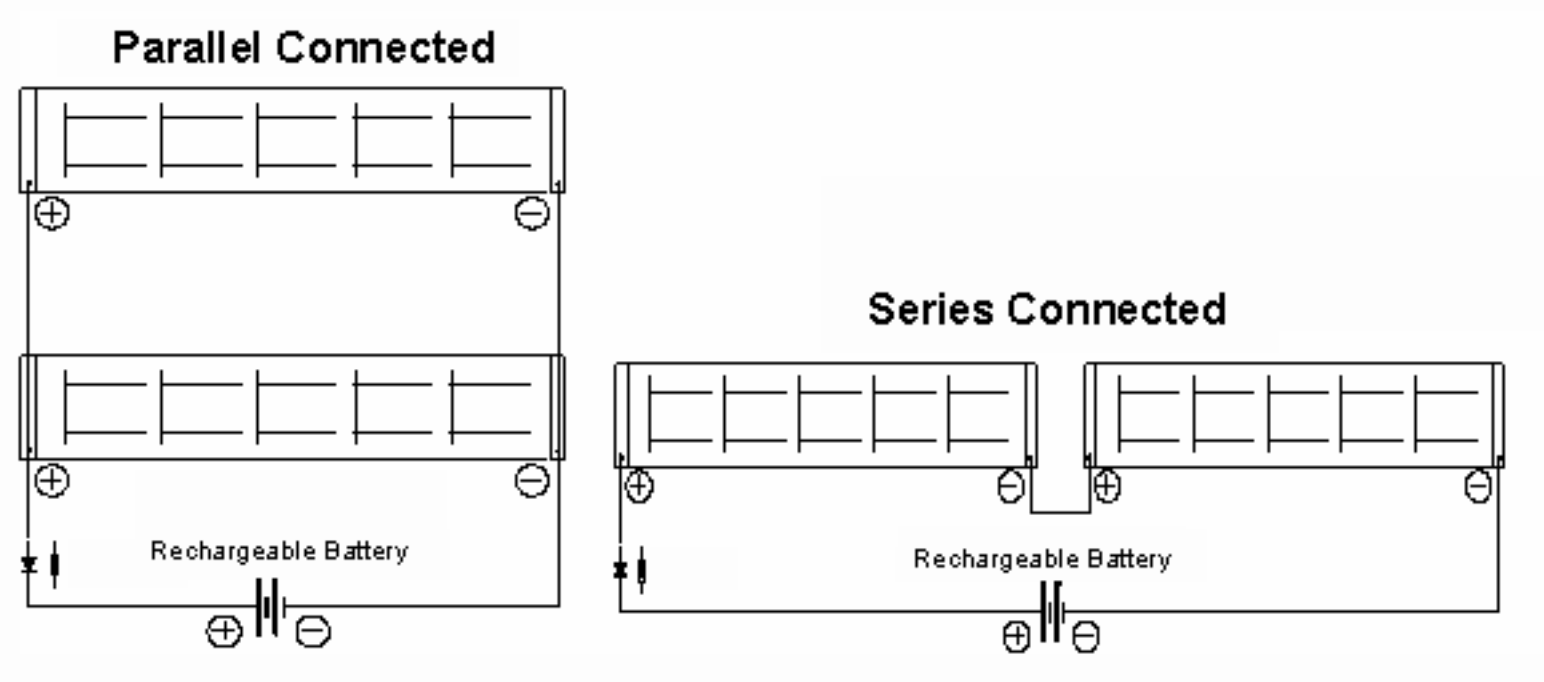
The diagram below graphically demonstrates parallel and series connected solar modules:




## 2. Module Selection: Use Environment

If the use environment is a permanent outdoor direct exposure environment, it is essential that the solar module system be UV-stabilized and protected from moisture. (In rare cases this may not be important if the required lifetime is less than one year.) Solar modules in the PowerFilm® WeatherPro™ Series are specifically designed for permanent outdoor direct exposure environments.

Other use environments are generally less demanding and do not require the added protection offered by the PowerFilm® WeatherPro™ Series. Use environments and usage patterns vary significantly. Always test the selected solar module in its specific use environment and according to the usage pattern to confirm it meets those aspects of the specific application needs.

## 3. Module Selection: Specific Application Needs

Some applications have specific needs. Examples include: ultra thin profile, specific footprint, ability to connect the solar module to the load from the back side of the module, pressure sensitive adhesive, etc.

To meet specification needs we have developed several PowerFilm® Series.



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# III PowerFilm® Series Descriptions

## PowerFilm® ® Wireless Electronics Series

Modules in the PowerFilm® Wireless Electronics Series offer a new opportunity to solve the old problem of limited power for wireless electronics for portable and remote applications. PowerFilm® Wireless Electronics modules are lightweight, paper thin, and durable. Their ultra-thin profile enables them to be easily integrated with devices for solar recharging or direct powering. Modules have been specifically developed to recharge AA, AAA, and 6- and 12-volt batteries. These modules do not have a UV-stabilized surface. For connection, just solder or crimp to the copper tape.

## PowerFilm® RC Aircraft Series

The PowerFilm® RC Aircraft Series modules are designed to be easily integrated with RC Aircraft. These PowerFilm® modules are very lightweight, can be soldered to from the back of the module via the extended copper tape, and have an extra edge seal for protection from fuel contamination and weather. Modules are available with a strong pressure sensitive adhesive for simple bonding. These modules do not have a UV-stabilized surface. For connection, just solder to the copper tape.

## PowerFilm® WeatherPro™ Series

The PowerFilm® WeatherPro™ Series is the right choice for permanent outdoor applications that are directly exposed to the elements. The especially rugged construction of these PowerFilm® modules includes a UV-stabilized surface, extra edge seal for weather protection, and tin-coated copper leads that extend from the module. Coating the leads with an RTV silicon compound can provide a tightly sealed package.



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# IV PowerFilm® Product Line Overview

The PowerFilm® Product Line Overview highlights the solar modules available in each PowerFilm® Series. We strongly encourage first to try one of these standard products. If you require a custom product to meet your needs, please contact your PowerFilm® representative.

# Product Line Overview

March 20, 2003

| Operating Voltage | PowerFilm® Wireless Electronics Series | PowerFilm® RC Aircraft Series | PowerFilm® WeatherPro™ Series |
|---|---|---|---|
| **3 V** | PowerFilm SP3-37<br>PowerFilm TX3-25<br>PowerFilm MP3-37 | | |
| **3.6 V** | PowerFilm MPT3.6-75<br>PowerFilm MPT3.6-150 | | |
| **4.2 V** | PowerFilm SP4.2-37 | | |
| **4.8 V** | PowerFilm MPT4.8-75<br>PowerFilm MPT4.8-150 | | |
| **6 V** | PowerFilm MPT6-75<br>PowerFilm MPT6-150 | | |
| **7.2 V** | PowerFilm MP7.2-75<br><br>PowerFilm MP7.2-150 | PowerFilm RC7.2-37<br>PowerFilm RC7.2-37 PSA<br>PowerFilm RC7.2-75<br>PowerFilm RC7.2-75 PSA | PowerFilm P7.2-75<br><br>PowerFilm P7.2-150 |
| **15.4 V** | PowerFilm MPT15-75<br>PowerFilm MPT15-150 | | PowerFilm PT15-75<br>PowerFilm PT15-150<br>PowerFilm PT15-300 |



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# V PowerFilm® Wireless Electronics Series

## Leads and Testing

The leads on the modules in the PowerFilm® Wireless Electronics Series are the copper tape strips located at each end of the solar module. Remember to check the Polarity! To test the module using alligator clips for the connection to the tester, ensure the clips make direct contact with the copper tape. The coating over the copper tape will likely need to be scraped away to ensure direct contact.

## Connecting the PowerFilm® Module to a Load

Connection methods include soldering, crimping or using alligator clips. Remember to check the Polarity!

### Soldering

The solar modules should be soldered to from the front. The positive copper contact is on one end and the negative is on the other end (see section on Polarity).

Use the hot tip of the soldering iron to melt through the clean coating of the copper tape. Be careful not to burn through more than just the thin clear coating. Burning too deeply can damage the solar module. Although not necessary, it is possible to remove a small piece of the clear coating with a sharp knife prior to soldering to the copper tape.

Good contact can be made by melting and depositing a dot of solder to the exposed copper tape. Use a low temperature soldering iron adjusted to about 600 to 650 degrees (F). It is also acceptable to solder directly to the copper tape, without using a solder dot.

### Crimping

A pressure method of mechanically securing a terminal, splice or contact to the copper strips may be used. There are many sources of crimp connectors, such as Amp (www.amp.com).

### Alligator Clips

Although not the most secure connection option, alligator clips may be used.

## Fastening the PowerFilm® Module

The PowerFilm® module may be fastened in several ways:

- Adhesives
  - Choose adhesive based on the material to which PowerFilm® is being attached
  - A wide range of adhesives are effective
    - Epoxy, silicon, super glue, 3M super 77 spray, double-sided acetic tape, etc.
    - Be careful not to get any adhesive on the front side (dark side) of the module since it will degrade overall performance
- Framed Enclosure



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# VI PowerFilm® RC Aircraft Series

## Leads and Testing

The leads on the solar modules in the PowerFilm® RC Aircraft series are the copper tape strips at each end of the module. In this series the copper tape is specially folded around the back of the solar modules so it is possible to solder to the backside of the module. Remember to check the Polarity!

## Connecting the PowerFilm® Module to a Load

Remember to check the Polarity!

### Soldering

The solar modules should be soldered to from the front. The positive copper contact is on one end and the negative is on the other end (see section on Polarity).

Use the hot tip of the soldering iron to melt through the clean coating of the copper tape. Be careful not to burn through more than just the clear thin coating. Burning too deeply can damage the solar module. Although not necessary, it is possible to remove a small piece of the clear coating with a sharp knife prior to soldering to the copper tape.

Good contact can be made by melting and depositing a dot of solder to the exposed copper tape. Use a low temperature soldering iron adjusted to about 600 to 650 degrees (F). It is also acceptable to solder directly to the copper tape, without using a solder dot.

Modules with Pressure Sensitive Adhesive (PSA) on the back require the release liner to be removed before the solder dot is placed. Once the solder dot is formed a wire can be attached.

## Fastening the PowerFilm® Module

### Modules without the Pressure Sensitive Adhesive (PSA)

A double-sided adhesive tape or spray adhesive may be used to mount the solar module. Be careful not to get spray on the front of the modules since this will degrade overall performance.

### Modules with the Pressure Sensitive Adhesive (PSA)

The release line on the PSA modules is clear, carefully pick at the back (silver side) corner of the module until the release liner starts to exfoliate. **Once the module with PSA is mounted it cannot be removed since the PSA adhesive is permanent!**



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# VII PowerFilm® WeatherPro™ Series

## Leads and Testing

The leads on the PowerFilm® WeatherPro™ Series are the tin-coated copper leads extending from the module. Remember to check the Polarity! To test the module using alligator clips, ensure the clips make direct contact with the copper tape. The coating over the copper tape will likely need to be scraped away to ensure direct contact.

## Connecting the PowerFilm® Module to a Load

Connection methods include soldering, crimping or using alligator clips. Remember to check the Polarity!

### Soldering

In the PowerFilm® WeatherPro™ Series the tin-coated copper leads extend from each end of the solar module. The positive copper contact is on one end and the negative is on the other end (see section on Polarity).

Good contact can be made by melting and depositing a dot of solder to the exposed copper tape. Use a low temperature soldering iron adjusted to about 600 to 650 degrees (F). It is also acceptable to solder directly to the tin-coated copper leads, without using a solder dot.

### Crimping

A pressure method of mechanically securing a terminal, splice or contact to the copper strips may be used. There are many sources of crimp connectors, such as Amp (www.amp.com).

### Alligator Clips

Although not the most secure connection option, alligator clips may be used.

## Fastening the PowerFilm® Modules

- Adhesives will NOT work since coating is a material from the Teflon family
- Mechanical fasteners
    - Use along the weather seal (extra material around edges of solar module)
    - Stay ¼" away from the active aperture area if using a fastener
    - Grommet with screws or bolts; ensure no damage to weather seal
    - Tube Clamp
    - Framed Enclosure



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# Standard Product List

March 21, 2003

## PowerFilm. Ultra Flexible Thin Film on Plastic Solar Modules

### PowerFilm® Wireless Electronics Series

| | Product | Operating Voltage | Operating Current | Typ Voc | Typ Isc | Total Size | Aperture Size | Total Thickness | Weight |
|---|---|---|---|---|---|---|---|---|---|
| * | PowerFilm SP3-37 | 3 V | 22 mA | 4.1 V | 30 mA | 64mm x 37mm (2.5 x 1.5 inches) | 50mm x37mm (2.0 x 1.5 inches) | 0.2mm (8mil) | 0.7g (0.03oz) |
| * | PowerFilm TX3-25 | 3 V | 25 mA | 4.1 V | 40 mA | 114mm x 25 mm (4.5 x 1.0 inches) | 100mm x25mm (3.9 x 1.0 inches) | 0.2mm (8mil) | 0.8g (0.03oz) |
| * | PowerFilm MP3-37 | 3 V | 50 mA | 4 .1 V | 60 mA | 114mm x 37mm (4.5 x 1.5 inches) | 100mm x37mm (3.9 x 1.5 inches) | 0.2mm (8mil) | 1.2g (0.04oz) |
| * | PowerFilm MPT3.6-75 | 3.6 V | 50 mA | 4.8 V | 65 mA | 74 mm x 75mm (2.9 x 3.0 inches) | 60mm x 75mm (2.4 x 3.0 inches) | 0.2mm (8mil) | 1.6g (0.06oz) |
| * | PowerFilm MPT3.6-150 | 3.6 V | 100 mA | 4.8 V | 130 mA | 74mm x 150mm (2.9 x 5.9 inches) | 60mm x 150mm (2.4 x 5.9 inches) | 0.2mm (8mil) | 3.1g (0.1oz) |
| * | PowerFilm SP4.2-37 | 4.2 V | 22 mA | 5.9 V | 30 mA | 84 mm x 37mm (3.3 x 1.5 inches) | 70mm x 37mm (2.8 x 1.5 inches) | 0.2mm (8mil) | 0.8g (0.03oz) |
| * | PowerFilm MPT4.8-75 | 4.8 V | 50 mA | 6.4 V | 65 mA | 94mm x 75mm (3.7 x 3.0 inches) | 80mm x 75mm (3.2 x 3.0 inches) | 0.2mm (8mil) | 1.9g (0.07oz) |
| * | PowerFilm MPT4.8-150 | 4.8 V | 100 mA | 6.4 V | 130 mA | 94mm x 150mm (3.7 x 5.9 inches) | 80mm x 150mm (3.2 x 5.9 inches) | 0.2mm (8mil) | 3.9g (0.1oz) |
| * | PowerFilm MPT6-75 | 6 V | 50 mA | 8.0 V | 65 mA | 114 mm x 75mm (4.5 x 3.0 inches) | 100mm x 75mm (3.9 x 3.0 inches) | 0.2mm (8mil) | 2.3g (0.08oz) |
| * | PowerFilm MPT6-150 | 6 V | 100 mA | 8.0 V | 130 mA | 114 mm x 150mm (4.5 x 5.9 inches) | 100mm x 150mm (3.9 x 5.9 inches) | 0.2mm (8mil) | 4.6g (0.1oz) |
| | PowerFilm MP7.2-75 | 7.2 V | 100 mA | 10.5 V | 125 mA | 253mm x 75mm (10.0 x 3.0 inches) | 240mm x 75mm (9.5 x 3.0 inches) | 0.6mm (24 mil) | 12.9g (0.5oz) |
| | PowerFilm MP7.2-150 | 7.2 V | 200 mA | 10.5 V | 150 mA | 253mm x 150mm (10.0 x 5.9 inches) | 240mm x 150mm (9.5 x 5.9 inches) | 0.6mm (24 mil) | 25.9g (0.9oz) |
| | PowerFilm MPT15-75 | 15.4 V | 50 mA | 19 V | 60 mA | 253mm x 75mm (10.0 x 3.0 inches) | 240mm x 75mm (9.5 x 3.0 inches) | 0.6mm (24 mil) | 13.0g (0.5oz) |
| | PowerFilm MPT15-150 | 15.4 V | 100 mA | 19 V | 120 mA | 253mm x 150mm (10.0 x 5.9 inches) | 240mm x 150mm (9.5 x 5.9 inches) | 0.6mm (24 mil) | 26.0g (0.9oz) |

### PowerFilm® RC Aircraft Series

| Product | Operating Voltage | Operating Current | Typ Voc | Typ Isc | Total Size | Aperture Size | Total Thickness | Weight |
|---|---|---|---|---|---|---|---|---|
| PowerFilm RC7.2-37 | 7.2 V | 50 mA | 10.5 V | 60 mA | 270mm x 55mm (10.6 x 2.2 inches) | 240mm x 37mm (9.5 x 1.5 inches) | 0.2mm (8mil) | 3.5g (0.1oz) |
| PowerFilm RC7.2-37 PSA** | 7.2 V | 50 mA | 10.5 V | 60 mA | 270mm x 55mm (10.6 x 2.2 inches) | 240mm x 37mm (9.5 x 1.5 inches) | 0.2mm (8mil) | 4.4g (0.2oz) |
| PowerFilm RC7.2-75 | 7.2 V | 100 mA | 10.5 V | 125 mA | 270mm x 90mm (10.6 x 3.5 inches) | 240mm x 75mm (9.5 x 3.0 inches) | 0.2mm (8mil) | 5.9g (0.2oz) |
| PowerFilm RC7.2-75 PSA** | 7.2 V | 100 mA | 10.5 V | 125 mA | 270mm x 90mm (10.6 x 3.5 inches) | 240mm x 75mm (9.5 x 3.0 inches) | 0.2mm (8mil) | 7.6g (0.3oz) |

### PowerFilm® WeatherPro™ Series

| Product | Operating Voltage | Operating Current | Typ Voc | Typ Isc | Total Size | Aperture Size | Total Thickness | Weight |
|---|---|---|---|---|---|---|---|---|
| PowerFilm P7.2-75 | 7.2 V | 100 mA | 10.5 V | 125 mA | 270mm x 100mm (10.6 x 3.9 inches) | 240mm x75mm (9.5 x 3.0 inches) | 1.1mm (44 mil) | 31.3g (1.1oz) |
| PowerFilm P7.2-150 | 7.2 V | 200 mA | 10.5 V | 250 mA | 270mm x 175mm (10.6 x 6.9 inches) | 240mm x150mm (9.5 x 5.9 inches) | 1.1mm (44 mil) | 54.9g (1.9oz) |
| PowerFilm PT15-75 | 15.4 V | 50 mA | 19 V | 60 mA | 270mm x 100mm (10.6 x 3.9 inches) | 240mm x75mm (9.5 x 3.0 inches) | 1.1mm (44 mil) | 31.8g (1.1oz) |
| PowerFilm PT15-150 | 15.4 V | 100 mA | 19 V | 120 mA | 270mm x 175mm (10.6 x 6.9 inches) | 240mm x150mm (9.5 x 5.9 inches) | 1.1mm (44 mil) | 56.4g (2.0oz) |
| PowerFilm PT15-300 | 15.4 V | 200 mA | 19 V | 250 mA | 270mm x 325mm (10.6 x 12.8 inches) | 240mm x300mm (9.5 x 11.8 inches) | 1.1mm (44 mil) | 94.5g (3.3oz) |

## Soltronix Solar-Recharged Consumer Electronics - Eliminate Replacement Batteries

### PowerFilm® Consumer Electronics

| Product | Description | Color | Batteries (included) | Key Features |
|---|---|---|---|---|
| Soltronix HR-1 BLUE | FM Stereo/AM Headphone Radio | BLUE | 1 - AAA NiMH | Dual headband, internal antenna, and extended bass |
| Soltronix HR-1GRAY | FM Stereo/AM Headphone Radio | GRAY | 1 - AAA NiMH | |

* Ultra Thin ( 8 mil) ** Pressure Sensitive Adhesive

Operating Voltage and Operating Current at AM1.5. Power performance may vary +/- 10% due to temperature variation, spectral variation, and related effects.

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See www.iowathinfilm.com for additional information including warranty

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